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## ROUTING OF CALL MADE TO SUBSCRIBER

### FIELD OF THE INVENTION

[0001] The invention relates to routing of a call made to a subscriber in a communication system during the time the subscriber is not registered in a network. Particularly the invention relates to routing of a call made to a subscriber in 'the third generation mobile communication systems'.

### BACKGROUND OF THE INVENTION

[0002] There is a wide variety of services provided through communication systems, particularly mobile communication systems, and new services are planned all the time. More and more of these services are likely to be non-standard services. For example, a large number of value added services, such as call forwarding, are standardized in the GSM system (Global System for Mobile communications), but it seems that these value added services will not be standardized in 'the third generation mobile communication systems', such as the UMTS (Universal Mobile Telecommunications System), but they are produced by using a variety of toolkits or protocols utilizing intelligent network-like control. Examples of these include CAMEL (Customised Applications for Mobile network Enhanced Logic), SIP (Session Initiation Protocol), OSA (Open Service Architecture), Parlay API (Application Protocol Interface), MexE (Mobile station Execution Environment) and SAT (SIM Application Toolkit).

[0003] The object of the 3GPP All-IP system, i.e. a UMTS system based on IP technology (Internet Protocol technology) and defined in the 3<sup>rd</sup> generation partnership project 3GPP, is that services associated with a mobile-terminating call are at least started, i.e. triggered from a call state control function S\_CSCF serving the subscriber, where to an interrogative call state control function I\_CSCF routes the call on the basis of the address obtained from a home subscriber server HSS. The interrogative call state control function I\_CSCF is the function through which calls terminating at the subscriber are routed. In systems where the signaling and the actual call are routed separately, call routing refers to the routing of signaling.

[0004] Sometimes, however, a subscriber is not registered in the system, for example because the user equipment of the subscriber is switched off. Thus the subscriber does not have a serving call state control function S\_CSCF, nor the control function that would trigger the services associated



with a mobile-terminating call, such as services associated with the forwarding of a terminating call.

[0005] One solution to the above problem is to provide these services by means of the interrogative call state control function I\_CSCF. In this solution, the home subscriber server HSS would transmit the subscriber's service information, for example CAMEL subscriber information CSI, as a routing instruction to the interrogative call state control function, when the subscriber is not registered in the network. The problem of this solution is, however, that the I\_CSCF should have a complete service interface, such as a CAMEL interface, it should be capable of dynamically triggering call state models and maintaining outgoing legs possibly associated with the service. In other words, the I\_CSCF should contain a wide variety of functions. Since the I\_CSCF very likely becomes the critical element of the system, it would be preferable that it would be as simple a device as possible, which is provided with only a few functions, so that its performance could be optimized without the above mentioned features required for providing the service.

#### BRIEF DESCRIPTION OF THE INVENTION

[0006] It is thus an object of the invention to provide a method and an apparatus implementing the method such that the above problems can be solved. The object of the invention is achieved by a method, a system, network nodes and user equipment, which are characterized in what is said in the independent claims. The preferred embodiments of the invention are disclosed in the dependent claims.

[0007] The invention is based on providing the network with a service functionality by which those services of a subscriber not registered in the network are handled that are associated with calls terminating at the subscriber, i.e. mobile-terminating calls, and giving the address of the network node including the above service functionality as a routing address for the call terminating at the subscriber when the subscriber is not registered in the network. The invention provides the advantage that in each occasion, the subscriber can be provided with services associated with a terminating call so that very few changes need to be made to the existing network nodes. Network nodes routing the terminating call need not be changed; it is quite sufficient that the network node giving routing information is arranged to give the address of the network node including the above service function, when

the subscriber is not registered in the network. This way, for example, the performance of the I\_CSCF can be optimized and the device can be kept as simple as possible.

5       **[0008]** In a preferred embodiment of the invention, at least one service content in the user equipment of the subscriber is loaded to the network node responsible for the services of an unregistered subscriber. Furthermore, this embodiment provides the advantage that some of the services associated with the mobile-terminating call can be implemented in the user equipment, but at the same time it can be made sure that these services  
10       can also be provided in cases where the subscriber is not registered in the network and the user equipment cannot thus provide the above services.

#### BRIEF DESCRIPTION OF THE DRAWINGS

15       **[0009]** In the following the invention will be described in greater detail in connection with the preferred embodiments, with reference to the attached drawings, in which:

**[0010]** Figure 1 is a block diagram illustrating a system according to a first preferred embodiment of the invention;

20       **[0011]** Figure 2 illustrates signaling according to the first preferred embodiment of the invention, when a subscriber performs the unregistration in the network; and

**[0012]** Figure 3 illustrates signaling according to a second preferred embodiment of the invention in connection with a mobile-terminating call to the subscriber that is not registered in the network.

#### DETAILED DESCRIPTION OF THE INVENTION

25       **[0013]** The present invention can be applied to any communication system where services intended for a subscriber are triggered from a network node serving the subscriber, the address of which network node is not a subscriber-specific constant but which address is to be detected from subscriber data when a mobile-terminating call is routed. Such systems  
30       include 'the third generation mobile communication systems', such as UMTS and IS-41, and the GSM system and the corresponding mobile communication systems, such as DCS 1800 (Digital Cellular System for 1800 MHz) and PCS (Personal Communication System), and systems based on the above mentioned systems, such as GSM 2+ systems. In the following the invention  
35       will be described by using the 3GPP All-IP system as an example without

restricting the invention thereto. The specifications of mobile communication systems, and the third generation mobile communication systems in particular, progress quickly. This may require additional changes to the invention. Therefore, all words and expressions should be interpreted broadly and they are intended for illustrating, and not restricting the invention.

[0014] In the 3GPP All-IP system 1, a difference is made between an access layer and a telephony layer, which may both have their own operators. (The division into layers is not shown in Figure 1.) Usually the access layer provides the user with a wireless access to external networks, such as IP networks (Internet Protocol), and the services thereof, such as Internet telephony (IPT, IP Telephony), such that the telephony layer is responsible for control. The IP telephony is in practice invisible to network nodes of the access layer, and they do not participate in the routing of the IP telephony. However, there are signaling connections from each level to various service platforms, such as a service control point of an intelligent network and an IP telephony application server (service platforms are not shown in Figure 1). IP telephony is a general term covering services from a standard voice telephony (VoIP, Voice over IP) to multimedia applications using IP data, voice and video.

[0015] Figure 1 shows a simplified network architecture and illustrates only those elements of the communication system 1 that are essential for understanding the invention. Network nodes shown in Figure 1 are logical units the implementation of which may differ from what is described here. It is obvious to a person skilled in the art that the system 1 also comprises other functions and structures, which need not be described in greater detail here.

[0016] User equipment UE comprises the actual terminal and a detachably connected identification card USIM, also called a subscriber identity module. In this context, the user equipment UE generally means the entity formed by the subscriber identity module and the actual terminal. The subscriber identification unit USIM is a smart card which comprises subscriber identity, performs authentication algorithms and stores authentication and cipher keys and subscription information necessary for the user equipment. The actual terminal can be any equipment capable of communicating in a mobile communication system. The terminal can thus be a simple terminal intended only for speech, or it can be a terminal for various services, operating

as a service platform and supporting the loading and carrying out of different service-related functions. The terminal can also be a combination of various devices, for example a multimedia computer with a Nokia card phone connected to it to provide a mobile connection. The user equipment operation according to a first preferred embodiment of the invention is explained in greater detail in connection with Figure 2.

[0017] In the example of Figure 1, the system 1 comprises a core network CN and a UMTS terrestrial radio access network UTRAN. The UTRAN is formed of a group of radio network subsystems (not shown in Figure 1) which are connected to the core network CN. A radio network subsystem can be based on the GPRS (General Packet Radio Service) of the GSM system, for example. The core network CN can be connected to external networks, such as IP networks IP. In the example of Figure 1, the core network comprises a home subscriber server HSS, an interrogative call state control function I\_CSCF and two serving call state control functions 2: S\_CSCF, which serves the user registered in the network and SUR\_CSCF, which serves the user that is not registered in the network.

[0018] The serving call state control function S\_CSCF is a network node which participates in controlling a call made by the user equipment of a subscriber and in supporting the establishment of calls terminating at the subscriber registered in the network, as well as in supporting the triggering of the services associated with these calls when the triggering conditions are fulfilled. In other words, the S\_CSCF controls call establishment and contains, among other things, a function corresponding to an intelligent network service switching function and the call state models of the IP telephony, by which the call establishment is controlled together with other network nodes, such as a service control point and IP telephony application servers (these are not shown in Figure 1). The S\_CSCF is the network node through which the signaling of a mobile-terminating call is transferred from the actual IP network IP, for instance. The S\_CSCF usually contains a subscriber database which logically corresponds to the visitor location register of the GSM system.

[0019] The SUR\_CSCF, a call state control function serving unregistered subscribers, is a function to which calls terminating at subscribers that are not registered are routed. The SUR\_CSCF supports the establishment of calls terminating at a subscriber that is not registered in the network and the triggering of services associated with these calls when the triggering conditions

are fulfilled. The SUR\_CSCF triggers the service in a service execution environment which is either external or internal. The interface to the external environment may be based, for example, on distributed object oriented technologies, such as CORBA (Common Object Request Broker Architecture),  
5 or one of the control protocols of the Intelligent Network. The execution environment may be based on Java virtual machine, for example. The SUR\_CSCF contains service control interfaces, such as a CAMEL interface, that are necessary for controlling calls terminating at subscribers. In the first preferred embodiment of the invention, the SUR\_CSCF thus includes call  
10 state models of the IP telephony, for instance, which are used together with other network nodes, such as a service control point and IP telephony application servers (these are not shown in Figure 1), for controlling the establishment of a mobile-terminating call. The SUR\_CSCF according to the first embodiment of the invention further comprises a virtual proxy in which a  
15 copy of a service content or service contents usually stored in the user equipment can be stored during the unregistration. The virtual proxy preferably comprises at least one execution environment which corresponds to the service platform for performing service contents when the conditions are fulfilled. Furthermore, the SUR\_CSCF according to the first preferred  
20 embodiment of the invention comprises a database corresponding to the visitor location register of the GSM system, or a connection to the database in which it temporarily stores subscriber data of an unregistered subscriber. In a second preferred embodiment of the invention, the SUR\_CSCF does not have a proxy nor a database nor a connection to the database. In other preferred  
25 embodiments of the invention, the SUR\_CSCF may comprise either a proxy or a database or a connection to the database. The operation of the SUR\_CSCF according to the invention is described in greater detail in Figures 2 and 3.

**[0020]** The interrogative call state control function I\_CSCF only participates in controlling the establishment of a call made to a subscriber, and  
30 it determines how the mobile-terminating call is to be routed. In other words, it is authorized to route calls terminating at a subscriber station. In the system 1, the I\_CSCF functions as an entry point for a mobile-terminating call and it interrogates the HSS in order to detect routing information. In the system of the invention, the routing information the I\_CSCF obtains is always the  
35 address of a serving call state control function 2, and the invention does not require any changes to the interrogative call state control function.

**[0021]** The functionality of various call state control functions I\_CSCF, S\_CSCF and SUR\_CSCF is not affected by the type of the access network. This means that the access network may be a wireless network, as in the example of Figure 1, or a wired network.

5           **[0022]** The home subscriber server HSS logically corresponds to the home location register of the GSM system, and subscriber data 3 for each subscriber of the home network are stored therein either permanently or semi-permanently such that the subscriber data are combined with a subscriber identifier 4, which in the GSM system, for example, is IMSI (International  
10 Mobile Subscriber Identity). (Figure 1 illustrates parts of subscriber data only for two subscribers.) In an address field 5, the home subscriber server HSS maintains subscriber-specific information on the address of the call state control function 2 serving the subscriber. In the first preferred embodiment of the invention, the address of the serving call state control function 2, which is  
15 used when the user equipment is not registered in the network, is maintained for each subscriber in an address field 6. In the second preferred embodiment of the invention, the home subscriber server maintains one common serving call state control function address which is used for all unregistered subscribers. In a third preferred embodiment of the invention, the address of  
20 the control function serving an unregistered subscriber is sometimes maintained for each subscriber separately, and sometimes a common address is used. The home subscriber server according to the third embodiment recognizes that the common address is used, for example because the subscriber data does not contain an address in the address field 6. In the first  
25 preferred embodiment of the invention, the home subscriber server always transmits the address of the address field 5 to the interrogative call state control function, and so during the unregistration of the subscriber the home subscriber server sets the address of the address field 6 to the address field 5. In the example of Figure 1, for example, the subscriber with an identifier IMSI2  
30 is a subscriber that is not registered in the network. In the second preferred embodiment of the invention, the home subscriber server checks whether the address field 5 is empty, and if it is, it transmits the commonly maintained address of the call state control function serving those that are not registered to the interrogative call state control function. However, regardless of the  
35 embodiment of the invention, the home subscriber server of the invention returns the address of the S\_CSCF or that of the SUR\_CSCF to the I\_CSCF

in response to the routing information request. The address may also be a pointer to the actual address.

[0023] In addition to prior art means, the system implementing the functions of the present invention and the network nodes of this system  
5 comprise means for providing a call state control function serving an unregistered subscriber and means for giving the address of this control function as a routing address in cases where the subscriber is not registered in the network. Moreover, the network nodes and the user equipment may  
10 comprise means for implementing the functions described in connection with Figures 2 and 3. The current network nodes and user equipment comprise processors and memory, which can be utilized in the functions according to the invention by configuring them. All changes necessary for implementing the invention can be made as added or updated software routines, by means of  
15 application-specific integrated circuits (ASIC) and/or programmable circuits, such as EPLD (Electrically Programmable Logic Device, FPGA (Field Programmable Gate Array).

[0024] Figure 2 illustrates signaling according to the first preferred embodiment of the invention when the subscriber station performs the unregistration. In the first preferred embodiment of the invention it is assumed  
20 that the subscriber is always registered in a serving call state control function. In the example of Figure 2 it is assumed that the home subscriber server is responsible for registration procedures.

[0025] In the example of Figure 2, the user equipment UE of the subscriber transmits an unregistration message 2-1 to the serving call state  
25 control function S\_CSCF which forwards the message 2-1 to the home subscriber server HSS. The HSS starts the unregistration procedure by transmitting a message 2-2 to the call state control function SUR\_CSCF serving the unregistered subscribers. In this message the HSS requests the control function to register the subscriber. The home subscriber server HSS  
30 obtains the address of the SUR\_CSCF from the subscriber data. The message 2-2 preferably indicates that the unregistration has been started by the subscriber. The message 2-2 differs from an ordinary registration message in that it does not contain an IP address for the subscriber (user equipment). In response to the registration request of the message 2-2, the SUR\_CSCF  
35 transmits a message 2-3 in which it requests subscriber data from the home subscriber server HSS. The home subscriber server HSS transmits subscriber



data in a message 2-4, and the subscriber data is then stored by the SUR\_CSCF in a database. The message 2-4 contains at least subscriber data relating to the services of a mobile-terminating call. In the first preferred embodiment of the invention, CAMEL subscriber data CSI of the subscriber are transmitted in the message 2-4. Since the message 2-2 indicated that the subscriber started the unregistration, the call state control function serving the unregistered subscribers SUR\_CSCF transmits the user equipment UE of the subscriber a message 2-5 in which it requests the user equipment to transmit service contents in the user equipment to itself. In response to this request, the user equipment transmits at least those service contents to the SUR\_CSCF in a message 2-6 that relate to services associated with a mobile-terminating call. The user equipment may also transmit all of its service contents in the message 2-6. After receiving the message 2-6, the SUR\_CSCF stores the service contents the message contains. The service contents are preferably stored in connection with other subscriber data, but they can also be stored somewhere else. Thereafter, the SUR\_CSCF transmits the home subscriber server HSS a message 2-7 in which the SUR\_CSCF acknowledges the registration request as accepted. The home subscriber server HSS sets the address of the SUR\_CSCF as the address of the call state control function serving the subscriber to the subscriber data and transmits the acknowledgement of the unregistration in a message 2-8 to the call state control function serving the subscriber S\_CSCF which, in response to the message 2-8, deletes the subscriber data associated with the subscriber from its database and transmits the unregistration acknowledgement to the user equipment UE of the subscriber in a message 2-9.

**[0026]** When the subscriber registers in the network again, the subscriber data in the SUR\_CSCF are deleted and the address of the SUR\_CSCF is replaced by the address of the call state control function serving the user S\_CSCF in the subscriber data of the home subscriber register.

**[0027]** If, in the first preferred embodiment of the invention, the unregistration is triggered by the HSS, for instance because no connection could be established with the user equipment, or the unregistration is triggered by a timer, the message 2-2 indicates that the unregistration is triggered in the network. In this case, the SUR\_CSCF does not transmit the message 2-5, but instead it transmits the acknowledgement message 2-7 directly after storing

the subscriber data. Naturally the messages 2-1, 2-6 and 2-9 are not transmitted. In another embodiment of the invention, the SUR\_CSCF may try to set up a connection to the user equipment (i.e. to transmit the message 2-5) in order to obtain the service contents, although the unregistration was triggered by the network. In this embodiment, the message 2-2 need not indicate the source of the unregistration.

**[0028]** If the unregistration is triggered by the S\_CSCF, the S\_CSCF transmits the message 2-1 to the HSS and preferably indicates in the message that the unregistration was triggered by the S\_CSCF.

**[0029]** In a preferred embodiment of the invention, the user equipment is arranged to transmit the service contents to the SUR\_CSCF in its unregistration message. In other words, the message 2-1 contains the service contents of the user equipment. In this embodiment the messages 2-5 and 2-6 are not transmitted.

**[0030]** In a preferred embodiment of the invention, the service contents of the user equipment are also maintained in a server or the like in the network. The service contents may be retrieved by using the subscriber identity which can, for example, be a part of an internet uniform resource locator (URL) of the service contents of the user equipment. Another possibility is that the user equipment only transmits a pointer or pointers to the service content(s) and the potential parameters in the message 2-1 or 2-5.

**[0031]** In a preferred embodiment of the invention, the SUR\_CSCF is arranged to wait for the reply 2-6 for a predetermined time. If the reply does not arrive within the predetermined time, the SUR\_CSCF interprets it so that there were no service contents in the user equipment, and so it transmits the message 2-7. This embodiment provides the advantage that all user equipment need not support the transmission of the service contents to the network.

**[0032]** In a preferred embodiment of the invention, the service content or a part of the service content of the user equipment is not copied to the SUR\_CSCF. In this embodiment the message 2-2 does not indicate what has triggered the unregistration, nor does the SUR\_CSCF transmit the message 2-5 (and correspondingly, the user equipment does not transmit the message 2-6).

**[0033]** In a preferred embodiment of the invention, the SUR\_CSCF stores at least subscriber data relating to the services of a mobile-terminating

call permanently in its database which it uses. In this embodiment, the SUR\_CSCF checks after the message 2-2 whether the subscriber data or some of the subscriber data are to be found in the database, and if they are, the SUR\_CSCF checks whether also service content(s) is/are to be found, and  
5 if they are found, too, the SUR\_CSCF transmits the message 2-7 in response to the message 2-2. In this embodiment, the HSS can be arranged to update subscriber data each time the information of the HSS is updated.

**[0034]** In a preferred embodiment of the invention, the user equipment is arranged to transmit its service content(s) or a pointer/pointers  
10 and potential parameters to the network during each registration in the network, and the network is arranged to transmit the information transmitted by the user equipment to the SUR\_CSCF which stores the information such that it can be used when the user equipment is not registered in the network. In another preferred embodiment of the invention, the user equipment  
15 transmits the information only when it detects that its service content(s) have changed.

**[0035]** In the second preferred embodiment of the invention, when the subscriber performs the unregistration in the network, the HSS deletes the address of the S\_CSCF and transmits an acknowledgement of this. In the  
20 second preferred embodiment of the invention, only the messages 2-1 and 2-8 are transmitted, and, if it was the subscriber that triggered the unregistration, also the message 2-9.

**[0036]** Figure 3 illustrates operation according to the second preferred embodiment of the invention, when a call is terminating at a  
25 subscriber that is not registered in the network. The interrogative call state control function I\_CSCF requests a routing instruction from the home subscriber server HSS of the user equipment in a message 3-1. The HSS checks the address of the call state control function serving the subscriber. Since it is empty, the HSS gives the SUR\_CSCF address common to all  
30 subscribers as the routing instruction in a message 3-2 in the second preferred embodiment of the invention. Thereafter, the I\_CSCF transmits a call set-up request to the SUR\_CSCF in a message 3-3. In the second preferred embodiment of the invention, the SUR\_CSCF does not store data on the subscriber in its files, nor does the subscriber register in the SUR\_CSCF. In a  
35 message 3-4, it transmits a subscriber data request to the home location server HSS which transmits at least those subscriber data that relate to

services of a mobile-terminating call to the SUR\_CSCF in a message 3-5. The same subscriber data as in the message 2-4 are preferably transmitted in the message 3-5. By means of these subscriber data, the SUR\_CSCF triggers the required services when the triggering conditions are fulfilled. More specifically,  
5 the SUR\_CSCF immediately starts to implement the additional services according to the "not reachable" -state, and does not try to route the call to the subscriber.

**[0037]** The second preferred embodiment of the invention provides the advantage that subscriber data are not unnecessarily transmitted to the  
10 SUR\_CSCF, but they are only transmitted when they are needed.

**[0038]** In a preferred embodiment of the invention, which is based on the second preferred embodiment, in response to giving the SUR\_CSCF address as the routing address of the subscriber in the message 3-2, the home subscriber server HSS transmits at least those subscriber data that  
15 relate to the services of a mobile-terminating call to the SUR\_CSCF in the message 3-5. Thus, in this embodiment the SUR\_CSCF need not separately request the subscriber data (i.e. the message 3-4 is not transmitted).

**[0039]** In a preferred embodiment of the invention, which is based on the second preferred embodiment, the SUR\_CSCF stores the subscriber data received in the message 3-5 in a database and checks before  
20 transmitting the message 3-4, whether the data on the subscriber indicated in the message 3-3 are to be found in the file, and if they are, the SUR\_CSCF uses them and does not transmit the message 3-4. In this embodiment, the home subscriber server is arranged to transmit a deregistration message to  
25 the SUR\_CSCF during the subscriber's registration in the network (and in the S\_CSCF). Because of the deregistration message, the SUR\_CSCF deletes the data on the subscriber from its file.

**[0040]** In a preferred embodiment of the invention, which is based on the second preferred embodiment, the SUR\_CSCF is arranged to store the  
30 service content(s) or the pointer/pointers to the service content(s) and the potential parameters, which are transmitted by the user equipment to the network.

**[0041]** In the first preferred embodiment of the invention, the subscriber data are in the SUR\_CSCF, so the messages 3-4 and 3-5 are not  
35 needed.

**[0042]** The signaling messages in Figures 2 and 3 are not in an absolute chronological order and they can be transmitted in a different order. Other signaling messages can also be transmitted, and/or other functions can be performed also between the messages. For example, the SUR\_CSCF can store only those subscriber data that relate to the services of a mobile-terminating call, although the home subscriber server would also transmit other subscriber data. Some of the messages shown in Figures 2 and 3 can also be left out. The signaling messages are only examples and they may comprise several independent messages for transferring the same information. In addition, the messages may also comprise other information.

**[0043]** The above preferred embodiments of the invention are only examples, and in order to have new embodiments according to the invention the features described in the embodiments can be combined in a different manner than what is described above.

**[0044]** In the above, the term 'call' not only refers to a common call but also to other, possibly virtual, connection states whereto user data transmission, such as data session or packet data transmission, is associated. Examples include a packet radio session (such as a GPRS session), VoIP (Voice over IP) session and multimedia session according to H.323. User data may include a variety of components, such as voice, video image and data. The term 'call' also covers signaling required in the transmission of user data flow, and services similar to a call, which may be unidirectional, directed to a group (or groups) or broadcasts in a specific area, for instance.

**[0045]** Although the invention has been described above assuming that the service is triggered when the triggering conditions are fulfilled, it is obvious to a person skilled in the art how to apply the invention when there are no triggering conditions, i.e. in cases where the service is always triggered.

**[0046]** Although the invention has been described above such that a call state control function serves unregistered subscribers it is obvious to a person skilled in the art that unregistered subscribers can be served by other functions/network nodes, such as a SIP CPS (Call Processing Server), for example.

**[0047]** It is obvious to a person skilled in the art that as technology develops, the basic idea of the invention can be implemented in a variety of ways. The invention and the embodiments thereof are not restricted to the above examples, but may be modified within the scope of the claims.